ADDENDUM #1
TO SPEC. 05-281
CONSTRUCTION OF COMMUNICATIONS TOWER AND PRE-FABRICATED BUILDING

Addendum #1 to Spec. 05-281 to Construction of Communications Tower and Pre-fabricated Building, bids to be opened on Wednesday, November 30, 2005 at 12:00 noon.

Attached is the GEOTECHNICAL ENGINEERING REPORT for the above-mentioned specification.

All other terms and conditions to remain unchanged.

Dated this 21st day of October, 2005.

Purchasing Department

Vince M. Mejer
Purchasing Agent

VMM/dw

GEOTECHNICAL ENGINEERING REPORT

PROPOSED TOWER

City of Lincoln

Near North 70th Street and Bluff Road

Lincoln, Nebraska

PREPARED FOR

City of Lincoln-Radio Shop

2540 Fair Street

Lincoln, Nebraska 68506

October 19, 2005

PREPARED BY

HWS
Solutions Through Service

HWS Consulting Group
825 J Street, Box 80358
Lincoln, NE 68501-0358
402.479.2200 • Fax: 402.479.2276
hws.com

October 19, 2005

Mr. Raymond Ryan
City of Lincoln-Radio Shop
2540 Fair Street
Lincoln, Nebraska 68506

REFERENCE: Proposed Tower
City of Lincoln
Near North 70th Street and Bluff Road
Lincoln, Nebraska

Dear Mr. Ryan:

HWS Consulting Group Inc. (HWS) is pleased to submit the enclosed report that summarizes the findings of a soil and foundation engineering study and provides recommendations related to the design and construction of the foundation for the referenced project.

If any questions arise concerning this report or if additional information is needed about foundation conditions at this site, please contact HWS for assistance.

Sincerely,

HWS CONSULTING GROUP INC.

Brandon Desh

Brandon L. Desh, E.I

BLD\bld
Enclosures
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Orig. & 2 pc.: City of Lincoln-Radio Shop

GEOTECHNICAL ENGINEERING REPORT

PROPOSED TOWER
CITY OF LINCOLN
NEAR NORTH 70TH STREET AND BLUFF ROAD
LINCOLN, NEBRASKA

Prepared
for

CITY OF LINCOLN-RADIO SHOP
2540 FAIR STREET
LINCOLN, NEBRASKA

OCTOBER 19, 2005

Prepared
by

HWS CONSULTING GROUP INC.
825 "J" Street
Lincoln, Nebraska 68508

CONTENTS

I. INTRODUCTION

The City of Lincoln-Radio Shop plans to construct a three legged, freestanding tower near the Lincoln Electric System substation on north 70^{th} Street between Interstate 80 and Bluff Road in Lincoln, Nebraska. The design of the tower had not been completed at the time of this report as the City of Lincoln is in the process of putting the project out for design. therefore, the specific dimensions and loading conditions of the tower were unavailable.

HWS Consulting Group Inc. (HWS) has prepared this report to present the findings of an exploration of the foundation soils at the project site and recommendations concerning the design and construction of the foundation for the proposed tower.

Field and laboratory work consisted of: (a) making auger borings and Dutch friction-cone soundings to determine the depth, thickness, and composition of each soil formation encountered to the depths of the borings, (b) performing a geologic study to determine the origin of the deposits underlying the site, and (c) performing standard tests to determine the engineering properties of the soil strata that would affect the performance of the structure.

An engineering evaluation has been made of subsurface conditions with respect to design and construction of the proposed tower. Recommendations are provided for suitable foundation soils, the allowable bearing pressure on the foundation soil, the minimum depth of footings, the modulus of subgrade reaction to be used in the design of footings, the types of soils to be used as backfill, and the placement of backfill.

II. SUBSURFACE EXPLORATION

A program of Dutch friction-cone soundings, test borings, and soil sampling was performed at the project site on September 14, 2005. Two (2) Dutch friction-cone soundings were made at the site. The results of the soundings were used to determine the depths for obtaining undisturbed soil samples from an exploratory boring made immediately adjacent to each sounding. Two (2) exploratory borings were taken to depths of 20 feet below the existing grade to establish the general subsurface conditions of the area under consideration.

The Dutch friction-cone soundings were performed with a mechanical penetrometer in accordance with ASTM D 3441-98, Standard Method for Deep, Quasi-Static, Cone, and Friction Cone Penetration Tests of Soil. The mechanical penetrometer operates incrementally, using a set of inner rods to operate a telescoping penetrometer tip and to transmit the components of penetration resistance (cone bearing and friction sleeve resistance) to the surface for measurement. The plots of the test data identify the relative positions and thicknesses of hard and soft layers. The borings were made in accordance with ASTM D 1452-80 (Reapproved 2000), Standard Practice for Soil Investigation and Sampling by Auger Borings. .

The vicinity map is presented in Appendix A. The penetration diagrams (see Appendix B) present the results of the Dutch friction-cone soundings. The boring logs (refer to Appendix C) present the data obtained in the subsurface exploration. The logs include the surface elevations, the approximate depths and elevations of major changes in the character of the subsurface materials, visual descriptions of the materials in accordance with the criteria presented in Appendix D, and groundwater data. Elevations (approximate) at the soundings and boring locations were determined by survey with reference to the bottom (at the ground surface) of the southeast corner steel fence post at the existing LES substation. The elevation of this benchmark was arbitrarily assigned a value of 100.0 feet. Water level readings were made in the auger borings at the time and under conditions stated on the boring log.

III. LABORATORY ANALYSES

The undisturbed soil samples obtained during the subsurface exploration were examined in the laboratory by a member of HWS' professional engineering staff to supplement the field identification. Standard tests were performed on selected samples to determine the engineering properties of the foundation materials.

The moisture contents and dry unit weights of selected undisturbed soil samples were determined in the laboratory. These test results are presented in the boring logs opposite the respective sample locations. The moisture contents were determined in accordance with either ASTM D 4643-00, Standard Test Method for Determination of Water (Moisture) Content of Soil by the Microwave Oven Method, or ASTM D 2216-98, Standard Test Method for Determination of Water (Moisture) Content of Soil and Rock by Mass. The dry unit weights were determined in accordance with the Displacement Method of the Corps of Engineers, EM1110-2-1906, Appendix II, Unit Weights, Void Ratio, Porosity, and Degree of Saturation. These data correlate with the strength and compressibility of the soil. High moisture content and low density usually indicate low strength and high compressibility.

The unconfined compressive strengths of several undisturbed samples were estimated in the laboratory with a calibrated hand penetrometer. These strengths are presented on the boring logs and are estimates only. Actual values are generally lower than the estimated values indicated on the boring logs.

The unconfined compressive strength of one undisturbed sample of the foundation material was determined in accordance with ASTM D 2166-00, Standard Test Method for Unconfined Compressive Strength of Cohesive Soil. These data are summarized in Table 1, and the complete test report is presented in Appendix E.

TABLE 1
Unconfined Compression Test Data

Boring No.	Depth ft	Moisture %	Dry Density lbf/ft^3	Unconfined Compressive Strength, tons/ft^2
B-1	10.4-11.1	28.4	91.7	1.0

An unconsolidated, undrained triaxial compression test was performed on one sample of foundation material to provide data on the shearing strength of this material. The triaxial compression test was performed in accordance with ASTM D 2850-95 (Reapproved 1999), Standard Test Method for Unconsolidated, Undrained Strength of Cohesive Soils in Triaxial Compression. The specimen was backpressure saturated prior to shearing. A summary of the test data is shown in Table 2, and the complete test reports are presented in Appendix F.

TABLE 2
Triaxial Compression Test Data

Boring No.	Depth ft.	"B" Parameter	Cohesion (c)* lbf/ft^2
B-1	5.7-6.3	0.96	753

*Assumes an internal angle of friction (ϕ)of 0°.

IV. GEOLOGY AND SITE CONDITIONS

The city of Lincoln lies in the Dissected Till Plains section of Nebraska, a part of the Central Lowland province of the Interior Plains physiographic division[1]. The project site is located in a loess-mantled upland area in the northeast portion of Lincoln. The tower site had been previously graded for the substation and is located in a cut section.

The subsurface materials encountered at the boring locations are briefly described below in descending order of occurrence. Detailed descriptions are provided in the boring logs, which are presented in Appendix C.

Soil Zone	Description
Peoria	Silty clay, 5 to 25 percent fine sand; medium plasticity; moist to wet; stiff to very stiff. The Peoria was found in both borings to a maximum depth of 6.5 feet in boring B-1.
Loveland	Lean clay; 25 percent fine to medium sand; medium plasticity; wet; stiff to very stiff. The Loveland underlies the Peoria in both borings to a maximum depth of 10.0 feet in boring B-1.
Glacial Till	Fat clay; 25 to 35 percent fine to coarse sand; high plasticity; wet; very stiff. The glacial till underlies the Loveland in both borings to the depth explored in boring B-1 and to a depth of 16.0 feet in boring B-2.
Glacial Outwash	Clayey sand; 70 percent fine to coarse sand; low plasticity; saturated; dense. The glacial outwash was found in boring B-2 below the glacial till to the depth of boring.

Groundwater was encountered in boring B-2 at an elevation of 88.2 feet (15.0 feet below existing grade). The water table was not encountered to the depth of boring B-1 (20.0 feet below existing grade). The water table could be expected to fluctuate several feet depending on surface drainage, rainfall, irrigation, vegetation, temperature, and other factors. In addition, perched water could develop within and atop of the glacial till during wet periods.

V. DISCUSSION AND RECOMMENDATIONS

Four basic requirements for a satisfactory foundation of a structure are as follows:

a. The base of the foundation must be located below the depth to which the soil is subject to frost action and seasonal volume change caused by alternate wetting and drying.

b. The foundation (including the earth beneath it) must be stable or safe from failure.

c. The foundation must not settle or deflect enough to disfigure or damage the structure.

d. The foundation structure must be properly located with respect to any future influence that could adversely affect its performance.

The following recommendations for design and construction of the foundation for the proposed tower are based upon site conditions, the engineering properties of the subsurface materials, and the requirements of the proposed structure.

1. Suitable Foundation Material. As discussed in the Introduction, the structural design of the tower had not been completed at the time of issuance of this report. Therefore, specific foundation information and loading conditions were unavailable at the time of this report.

Suitable foundation material for the pad footings was encountered below elevation 101.8' in boring B-1 and 102.7' in boring B-2 (0.5' below existing grade at both boring locations). Typically, the design of a free standing tower of this type is controlled by uplift forces. Two options to resist the uplift force are: (a) lower the footings and use the shear strength of the soil, the weight of the concrete, and the weight of the soil above the footing to resist the uplift force; and/or (b) add additional support to the footing with a helical-type anchor system.

[1] Physiographic Provinces of North America, Map by A. K. Lobeck, 1948; The Geographical Press; Columbia University, New York

For option (a), the sizes of the footings are needed to accurately calculate the amount of uplift resistance that will be generated. In addition, the location of the footing and depth below grade will contribute to the amount of resistance generated. HWS suggests calculating the estimated allowable uplift force of a footing as follows:

$$T_a = [(s_u) \text{ x } (p) \text{ x } (D) + \text{Base Weight W}] / \text{FS}$$

where s_u = the undrained shear strength, p = perimeter of footing experiencing pullout, D = depth to bottom of footing from ground surface, W = weight of concrete and weight of soil being uplifted, and FS = Factor of Safety (2.5). HWS recommends a maximum undrained shear strength (s_u) of 750 lbf/ft^2 for the onsite soil conditions.

For option 2, a supplier of helical anchor systems should be contacted to determine the specific system needed to resist the uplift forces.

2. Dewatering. Groundwater was encountered in boring B-2 at elevation 88.2 feet (15.0 feet below existing grade). The bottoms of the excavations made for the pad footings will likely bottom out above the current water table, but if the water table rises or a perched water table develops dewatering of the excavations might be necessary.

3. OSHA Excavation Requirements. Excavations that will be occupied by personnel should be made in accordance with the Occupational Safety and Health Administration (OSHA) Construction Standards-29 CFR Part 1926, Subpart P-Excavations as published in the Federal Register, Vol. 54, 209, Tuesday, October 31, 1989, Rules and Regulations. OSHA states that a soil should be reclassified if the properties, factors, or conditions affecting the soil's classification change in any way. Sheet piling and/or shoring will be necessary if the sides of the excavations can not be sloped to meet OSHA regulations.

4. **Allowable Bearing Pressure.** The allowable net bearing pressure on the natural materials located at or below 0.5' below existing grade is 2,000 lbf/ft^2. The net bearing pressure is the contact pressure at the base of the foundation in excess of the pressure at the same level due to the surrounding surcharge. The surcharge pressure is equal to the total weight of a column of soil that extends from the lowest immediately adjacent ground surface to the bottom of the foundation divided by the soil column's area.

5. **Settlement.** Settlement of the pad footings is expected to be negligible (less than ¼ inch) if the recommendations in this report are carried out.

6. **Minimum Depth of Footings.** The bottoms of the pad footings should be placed at a minimum depth of 40 inches below finished grade to provide reasonable protection against frost action and seasonal volume change.

7. **Vertical Modulus of Subgrade Reaction.** The suggested value of the vertical modulus of subgrade reaction to be used in the design of footings is 100 lbf/in^3.

8. **Types of Soils to be used as Backfill.** The backfill of the footings should be constructed of inorganic CL[2], ML[3], SM[4], and/or SC[5] materials (all with a liquid limit less than 50 and a plasticity index less than 30). The lean clays encountered at the project site are considered suitable for use as backfill of the footings. It should be noted, however, that some of the upper Peoria lean clays are low in moisture content and will require the addition of water to achieve a moisture content necessary for proper placement.

Any granular backfill should be capped with at least two feet of clay. Proposed backfill materials should be subject to approval by the Geotechnical Engineer. Representative samples

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[2] Lean clay, lean clay with sand and sandy lean clay.
[3] Silt, silt with sand and sandy silt.
[4] Silty sand.
[5] Clayey sand.

of the proposed backfill materials should be submitted to the Geotechnical Engineer at least three days prior to placement so the necessary laboratory tests can be performed.

9. Placement of Backfill. The suggested basis for controlling the placement of the backfill on the site, excluding free-draining granular materials, are the "optimum moisture content" and "maximum dry density" as determined by ASTM D 698-00a, Procedure A, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft^3) (600 kN-m/m^3). The recommended acceptable values of moisture content and degree of compaction are given in Table 3.

TABLE 3
Compaction Recommendations of Controlled Earth Fill and Backfill

Location	Soil Type	Minimum Moisture Content	Minimum Compaction*
Backfill of footings	Silts and Clays	2% Below Optimum	95%

10. Construction Observation. The foundation materials should be observed by the Geotechnical Engineer immediately prior to placement of the concrete. Severe changes in the condition of these materials can occur after initial preparation as the result of construction activities. Any foundation material that becomes disturbed should either be removed and replaced or reworked to meet the placement recommendations. Frequent testing by the Geotechnical Engineering Firm during compaction of backfill is necessary to verify proper placement. A professional opinion should be obtained from the Geotechnical Engineer that all backfill conforms to the placement recommendations presented above. If these testing services are not performed, the pad footings might not safely resist the design loads. As the

Geotechnical Engineer for this project, HWS has interpreted the results of the subsurface exploration to arrive at the recommendations presented in this report. Consequently, HWS is in the best position to relate actual observed conditions to those assumed for this report and to provide revised recommendations if differences are found during construction of the footings.

11. Applicability of Recommendations. The recommendations presented in this report are based in part upon HWS' analyses of the data from the Dutch friction-cone soundings and the soil borings. The penetration diagrams, boring logs, and related information depict subsurface conditions only at the specific sounding and boring locations and at the time of the subsurface exploration. Soil conditions might differ at other locations and might change with the passage of time. The nature and extent of any variations or changes (e.g., higher groundwater) might not become evident until construction of the footings for the referenced project have begun. If variations and changes in the soil conditions then appear, it will be necessary to re-evaluate the recommendations stated in this report.

VI. CONCLUSIONS

HWS concludes, on the basis of the findings of the subsurface exploration at the project site and the evaluation of the engineering properties of samples of the foundation materials, that the proposed tower can be safely supported by pad footings seated on firm natural materials.

This report has been prepared in accordance with generally accepted soil and foundation engineering practices for exclusive use by the City of Lincoln, the tower manufacturer, and the contractor for specific application to the proposed tower. The recommendations of this report are not valid for any other purpose.

HWS should be contacted if any questions arise concerning this report or if changes in the nature, design, or location of the structure are planned. If any such changes are made, the conclusions and recommendations contained in this report shall not be considered valid unless the changes are reviewed by HWS and the conclusions of this report are modified or verified in writing. This report shall not be reproduced, except in full, without the written approval of HWS Consulting Group Inc.

Submitted By

HWS CONSULTING GROUP INC.

Prepared by:

Brandon Desh

Brandon L. Desh, E.I.

Reviewed by:

REGISTERED PROFESSIONAL ENGINEER
DOYLE B. PETERSEN
E-5528
STATE OF NEBRASKA

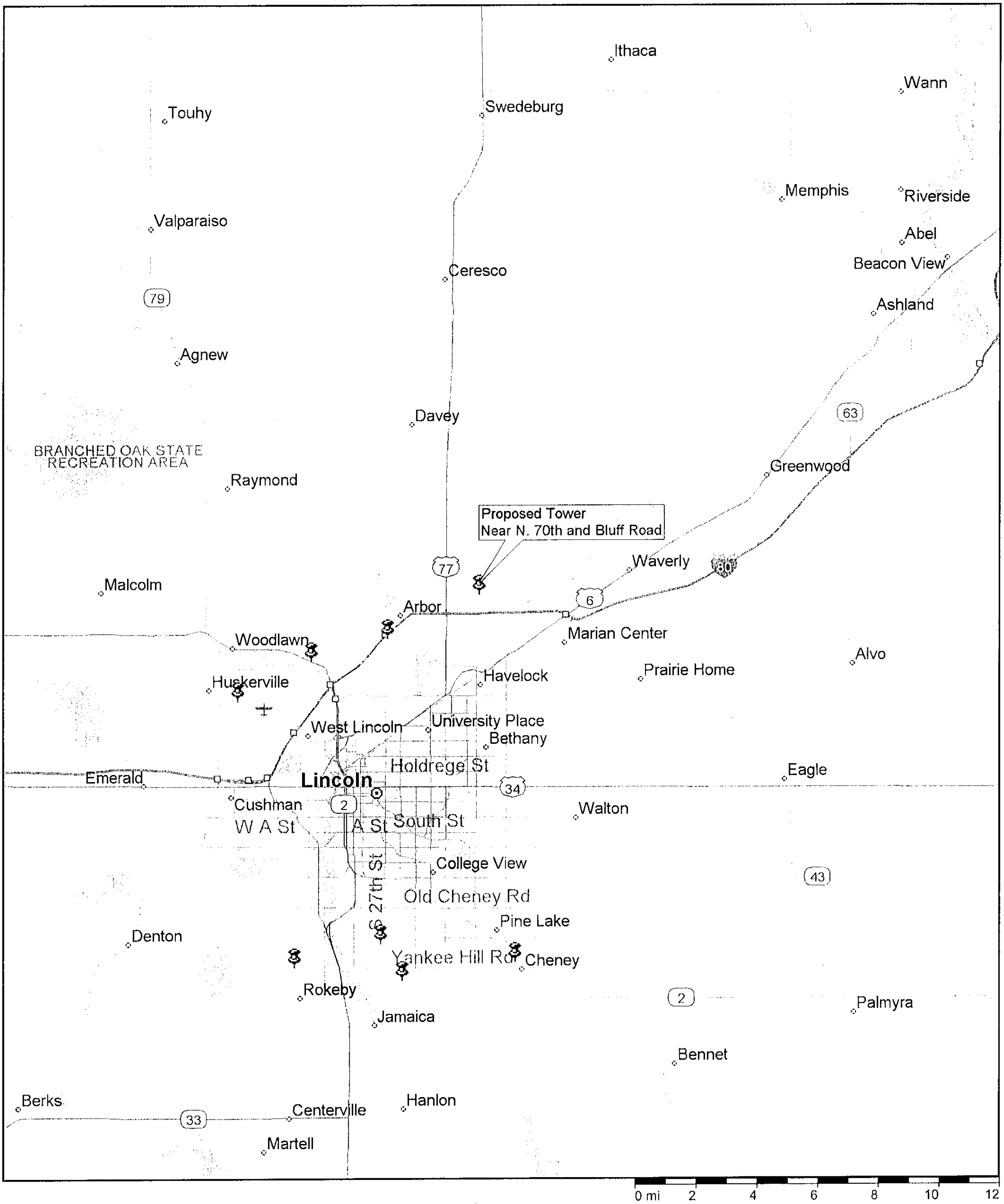
Doyle Petersen 10-19-05

Doyle B. Petersen, P.E.

APPENDIX A. VICINITY MAP AND BORING LOCATION PLAN

Figure A-1: Vicinity Map

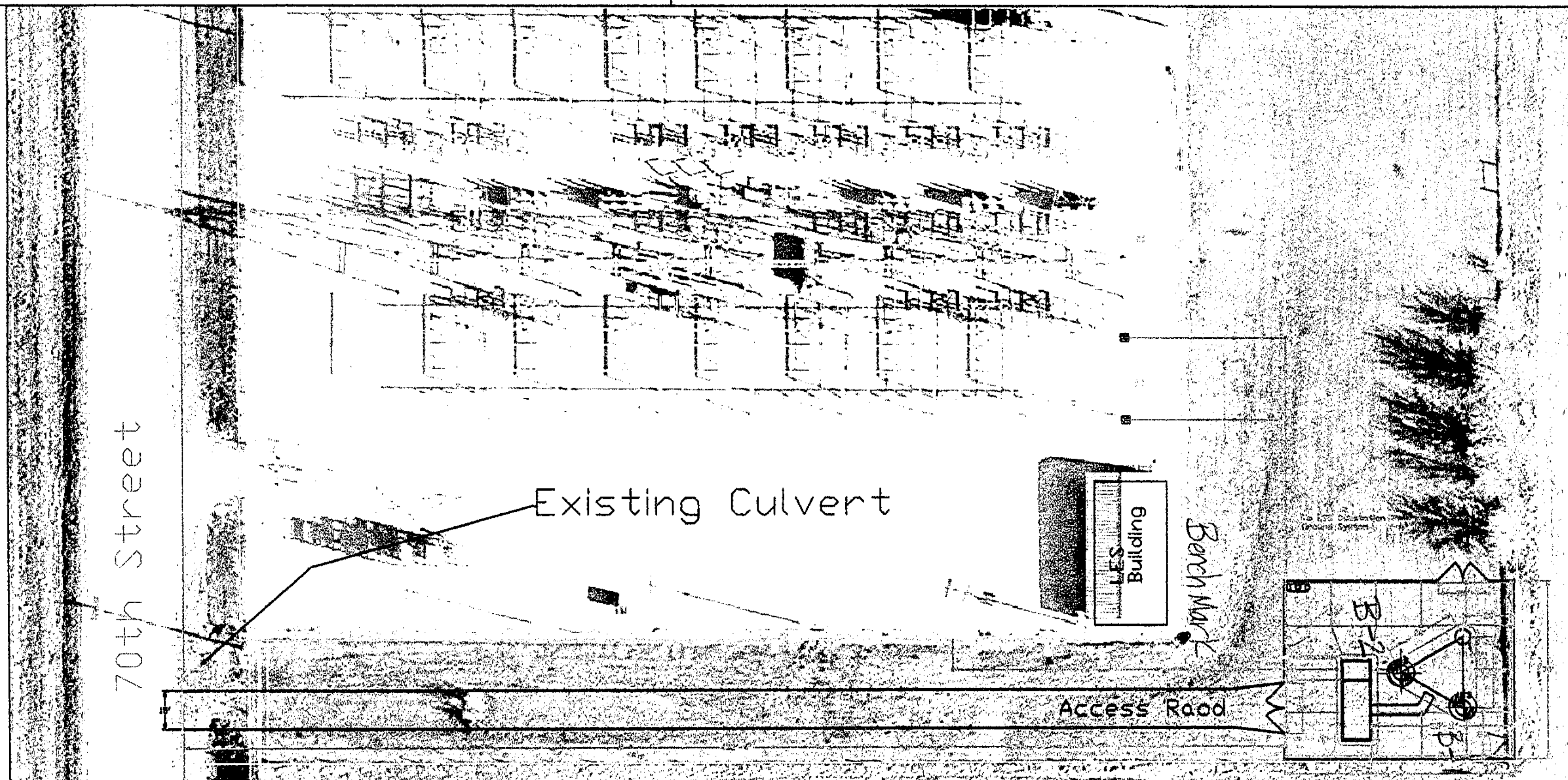
City of Lincoln Communcation Tower



Microsoft Expedia

Streets98

REVISIONS				
ZONE	REV	DESCRIPTION	DATE	APPROVED



Landfill Tower

City of Lincolln
Radio Maintenance

SIZE	FSCM NO.	DWG NO.	REV

SCALE		SHEET

N

SCALE 1" = 70'

FIGURE A-2

APPENDIX B.
DUTCH FRICTION-CONE PENETRATION DIAGRAMS

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PENETRATION DIAGRAM OF DUTCH FRICTION-CONE PENETROMETER

PROJECT: **City of Lincoln Communcation Tower**
N. 70th and Bluff Road, Lincoln, NE

SOUNDING NO.:	**S-1**	DATE:	**September 14, 2005**
LOCATION:	**B-1**	TESTED BY:	**CL**
SURFACE ELEVATION:	**102.3 feet**	RECORDED BY:	**SG**

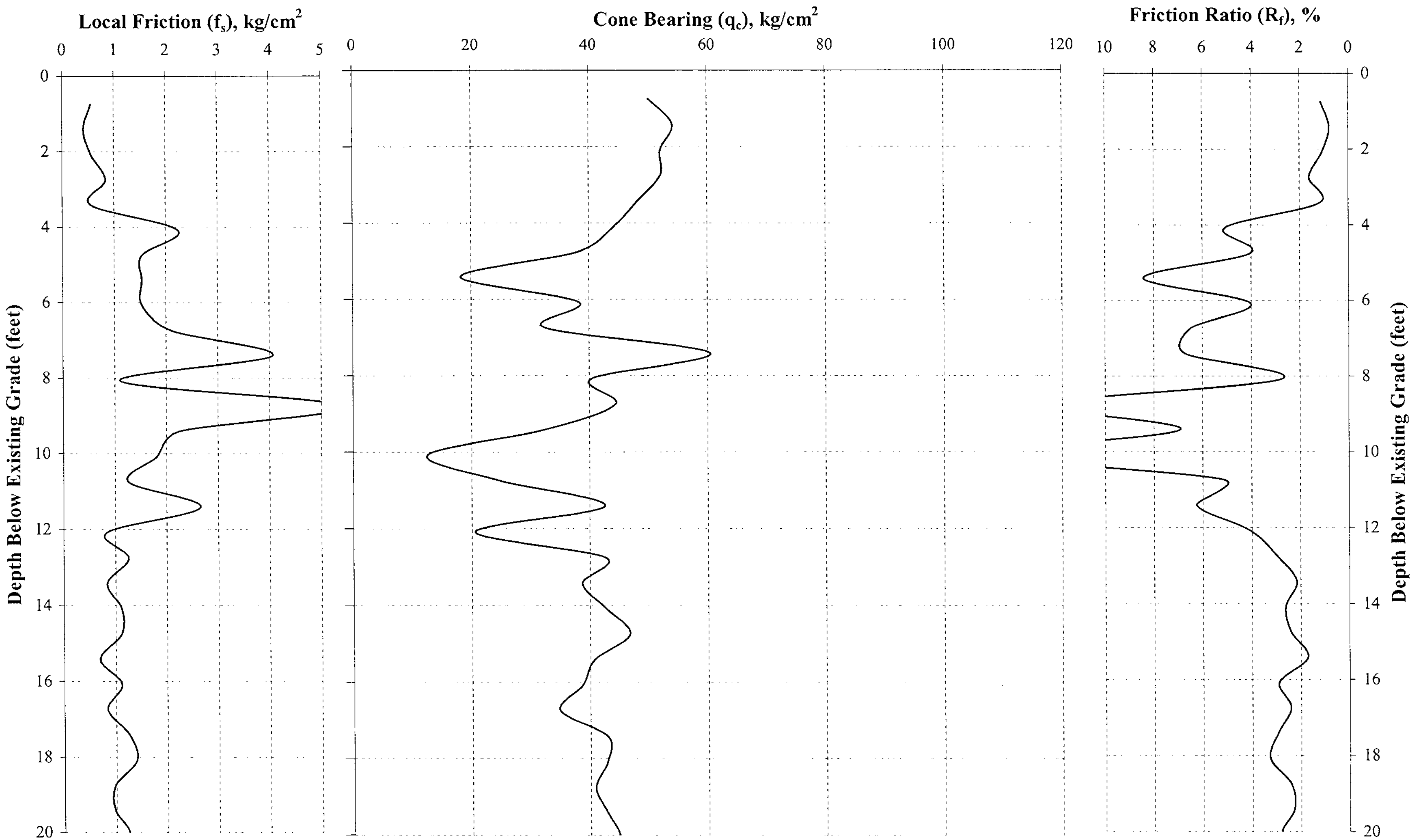

Figure B-1a

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Lincoln, NE 68501
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PENETRATION DIAGRAM OF DUTCH FRICTION-CONE PENETROMETER

PROJECT:	**City of Lincoln Communcation Tower**	SOUNDING NO.:	**S-1**		DATE:	**September 14, 2005**
	N. 70th and Bluff Road, Lincoln, NE	LOCATION:	**B-1**		TESTED BY:	**CL**
		SURFACE ELEVATION:	**102.3**	**feet**	RECORDED BY:	**SG**

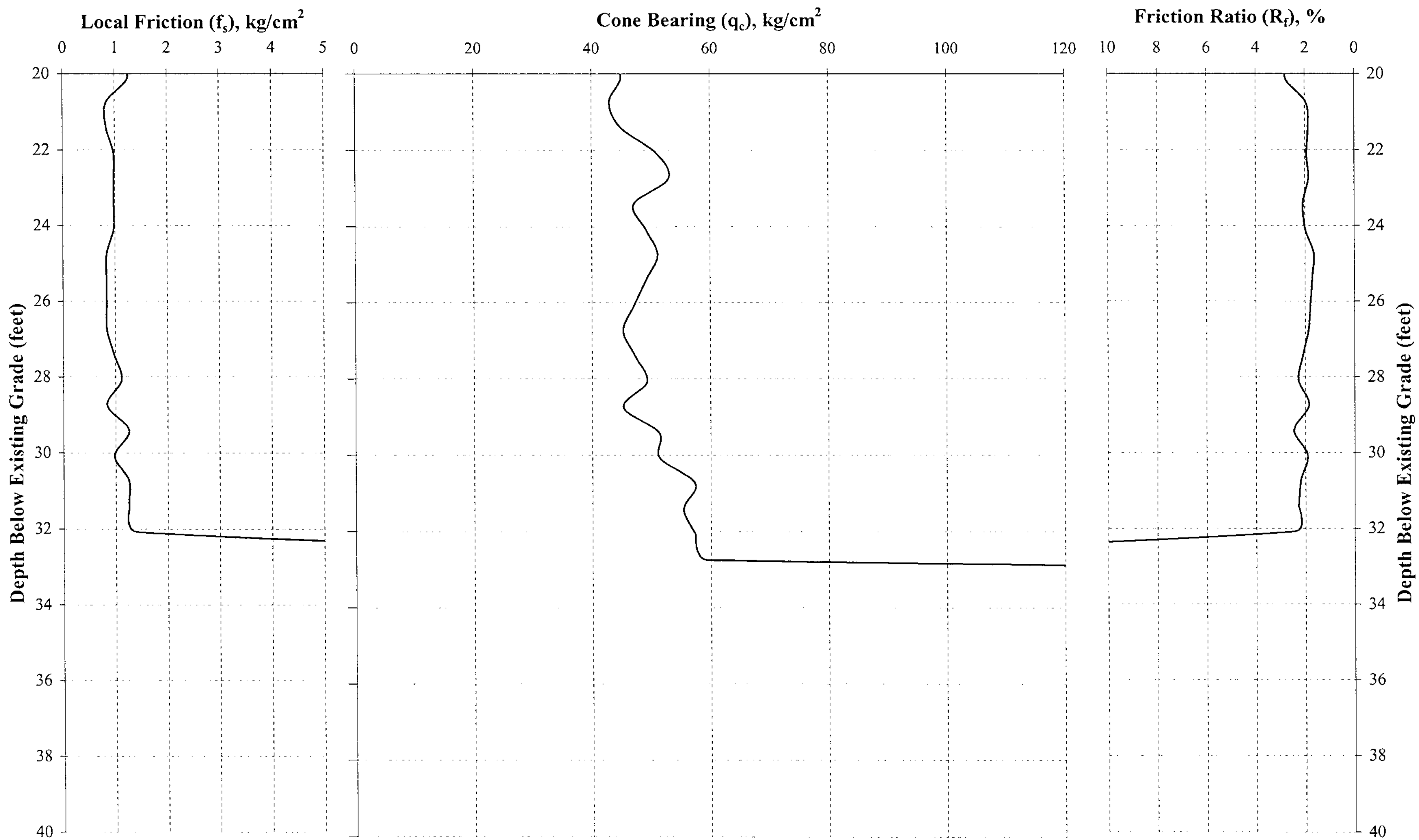

Figure B-1b

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PENETRATION DIAGRAM OF DUTCH FRICTION-CONE PENETROMETER

PROJECT: **City of Lincoln Communcation Tower**
N. 70th and Bluff Road, Lincoln, NE

SOUNDING NO.:	**S-2**	DATE:	**September 14, 2005**
LOCATION:	**B-2**	TESTED BY:	**CL**
SURFACE ELEVATION:	**103.2 feet**	RECORDED BY:	**SG**

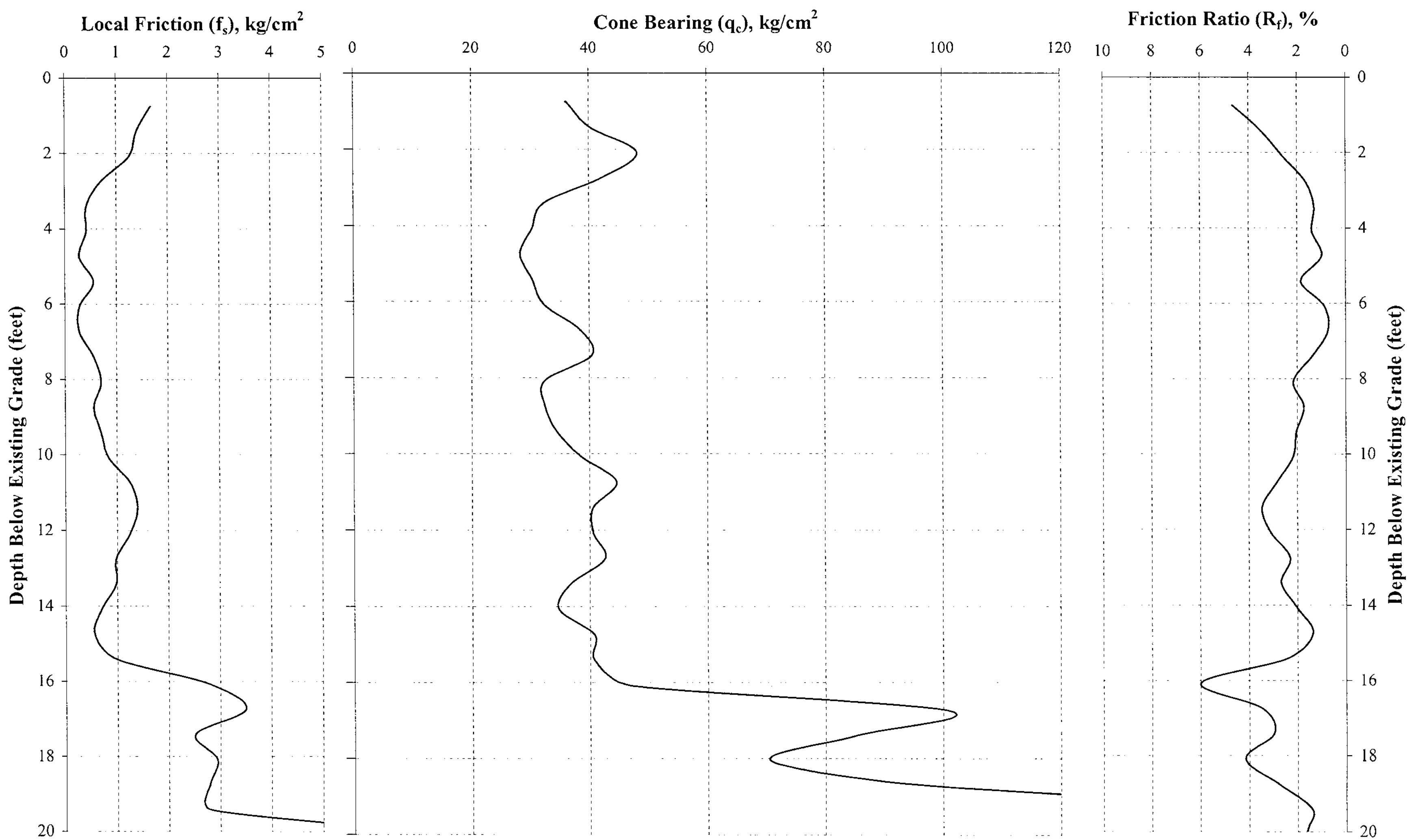

Figure B-2a

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LINCOLN OFFICE
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PENETRATION DIAGRAM OF DUTCH FRICTION-CONE PENETROMETER

PROJECT:	City of Lincoln Communcation Tower N. 70th and Bluff Road, Lincoln, NE	SOUNDING NO.:	S-2	DATE:	September 14, 2005
		LOCATION:	B-2	TESTED BY:	CL
		SURFACE ELEVATION:	103.2 feet	RECORDED BY:	SG

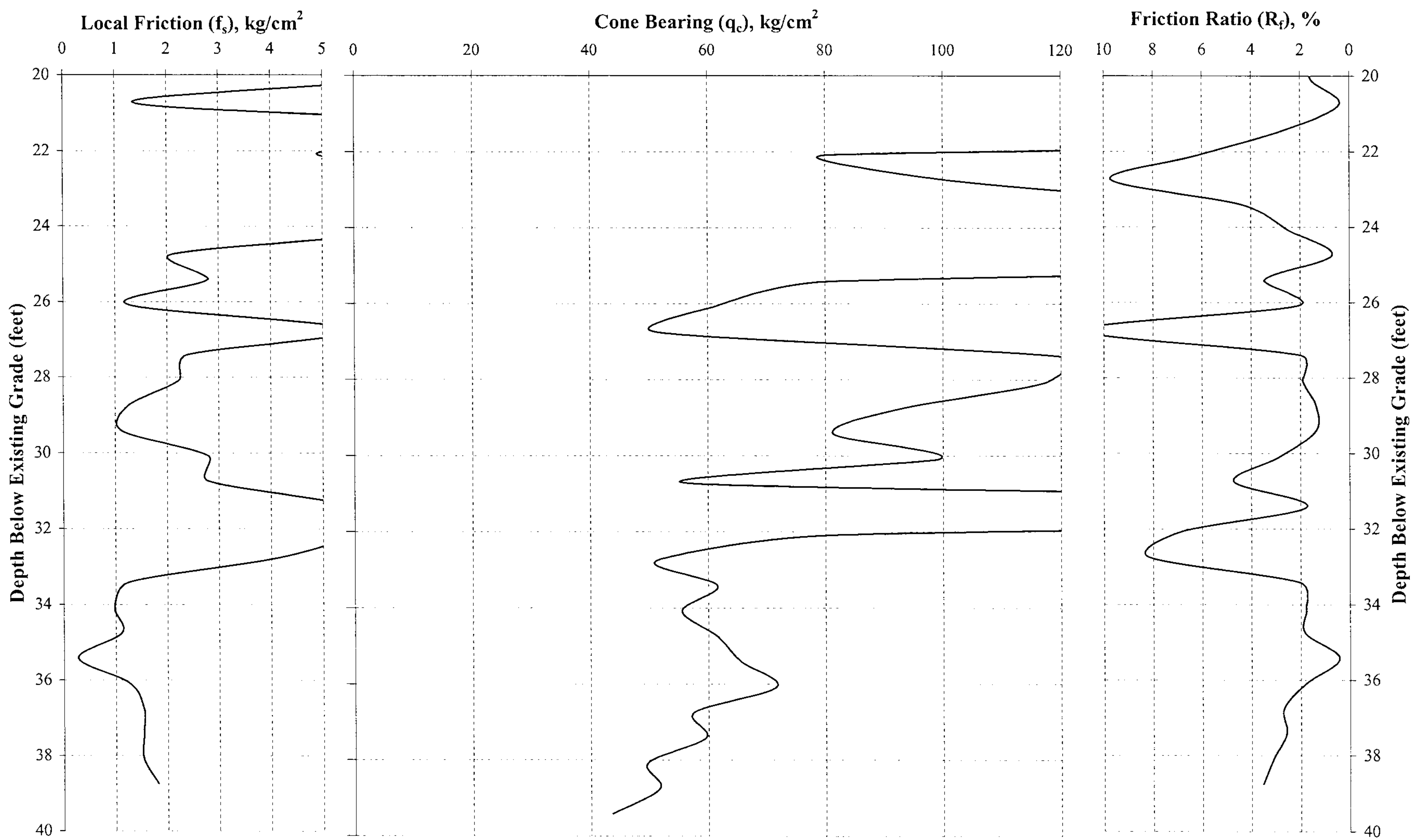

Figure B-2b

APPENDIX C. BORING LOGS

HWS
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825 J Street
Lincoln, NE 68508
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BORING LOG

PROJECT: City of Lincoln Communication Tower
LOCATION: Near North 70th and Bluff Road
Lincoln, Nebraska
JOB NO.: 52-86-3276
RIG / METHOD: CME 75HT / Straight Auger
CREW: CL & BM

BORING No.: 1
SHEET 1 of 1
DATE: 9-14-2005

WATER LEVELS ⊻ No groundwater encountered to the depth of boring

ELEV (USGS)	DEPTH (feet)	LOG	LITHOLOGY DESCRIPTION	SAMPLE	qu (tsf)	DRY DENSITY (pcf)	MOISTURE (%)	DEPTH (feet)
102.3	0.0		CL/ML - SILTY CLAY; 5% fine sand; medium plasticity; light yellowish brown mottled with dark yellowish brown brown; wet; stiff. (Peoria)					0.0
								2.5
								5.0
96.6	5.7		CL/ML - SILTY CLAY; 5% fine sand; medium plasticity; yellowish brown mottled with brown; wet; very stiff. (Peoria)	1	3.75*	98.0	18.5	
96.0	6.3		CL - LEAN CLAY; 5% fine sand; medium plasticity; brown mottled with reddish brown; wet; very stiff. (Loveland)					
95.5	6.8		CL - LEAN CLAY; 25% fine to medium sand; medium plasticity; reddish brown mottled with light grayish brown; wet; very stiff. (Loveland)					7.5
92.3	10.0		CL - SANDY LEAN CLAY; 35% fine to coarse sand; medium plasticity; yellowish brown mottled with reddish brown; wet; stiff. (Glacial Till)					10.0
91.9	10.4		CL - LEAN CLAY; light grayish brown mottled with brown; wet; stiff. (Glacial Till)	2	1.0*	92.3	26.5	
91.1	11.2		CH - FAT CLAY; 20% fine to coarse sand; high plasticity; grayish brown mottled with brown; wet; stiff. (Glacial Till)					
90.4	11.9		CH - FAT CLAY; 35% fine sand; high plasticity; grayish brown heavily mottled with light grayish brown white; wet; very stiff. (Glacial Till)					12.5
87.3	15.0		CH - FAT CLAY; 20% fine to coarse sand; high plasticity; yellowish brown mottled with gray; wet; very stiff. (Glacial Till)	3	4.0*	108.0	19.6	15.0
86.3	16.0		CH - FAT CLAY; 20% fine to coarse sand; high plasticity; gray mottled with yellowish brown; wet; very stiff. (Glacial Till)					
85.5	16.8		CH - FAT CLAY; 35% fine sand; high plasticity; grayish brown heavily mottled with light grayish brown white; wet; very stiff. (Glacial Till)					17.5
82.3	20.0		Boring Terminated at: 20.0ft					20.0

* Unconfined compressive strength was estimated using a calibrated hand penetrometer.

BORING LOG CITYCOMMTOWER_LOGS.GPJ HWS.GDT 10/20/05

HWS
Solutions Through Service

825 J Street
Lincoln, NE 68508
402-479-2200 * Fax: 402-479-2276

PROJECT: City of Lincoln Communication Tower

LOCATION: Near North 70th and Bluff Road
Lincoln, Nebraska

JOB NO.: 52-86-3276
RIG / METHOD: CME 75HT / Straight Auger
CREW: CL & BM

BORING LOG

BORING No.: 2

SHEET 1 of 1

DATE: 9-14-2005

WATER LEVELS ▽ 16.0 IAD ▼ 14.7 on 9-15-2005

ELEV (USGS)	DEPTH (feet)	LOG	LITHOLOGY DESCRIPTION	SAMPLE	qu (tsf)	DRY DENSITY (pcf)	MOISTURE (%)
103.2	0.0		CL/ML - SILTY CLAY; 25% fine sand; medium plasticity; yellowish brown slightly mottled with light yellowish brown dark grayish brown; moist; stiff. (Peoria)				
100.7	2.5		CL/ML - SILTY CLAY; Same as above except wet. (Peoria)				
97.2	6.0		CL - LEAN CLAY; 25% fine to medium sand; medium plasticity; reddish brown slightly mottled with light grayish brown; wet; stiff. (Loveland)				
95.2	8.0		CH - FAT CLAY; 15% fine to coarse sand; high plasticity; grayish brown mottled with reddish brown; wet; very stiff. (Glacial Till)	4	2.8*	104.5	19.4
93.2	10.0		CH - FAT CLAY; 25% fine to coarse sand; high plasticity; light grayish brown heavily mottled with dark yellowish brown light yellowish brown; wet; very stiff. (Glacial Till)				
90.2	13.0		CH - FAT CLAY; 25% fine to coarse sand; high plasticity; gray mottled with brown; wet; very stiff. (Glacial Till)	5	3.5*	107.8	19.6
88.2	15.0		CH - FAT CLAY; 35% fine sand; high plasticity; dark yellowish brown mottled with light brown white; saturated; very stiff. (Glacial Till)				
87.2	16.0		SC - CLAYEY SAND; 70% fine to coarse sand; low plasticity; yellowish brown mottled with light grayish brown; saturated; dense. (Glacial Outwash)				
83.2	20.0		Boring Terminated at: 20.0ft				

DEPTH (feet): 0.0, 2.5, 5.0, 7.5, 10.0, 12.5, 15.0, 17.5, 20.0

* Unconfined compressive strength was estimated using a calibrated hand penetrometer.

Figure C - 2

APPENDIX D.
CRITERIA USED FOR VISUAL SOIL CLASSIFICATION

TABLE D-1

Soil Classification Chart

Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests[A]			Group	Soil Classification: Group Symbol	Soil Classification: Group Name[B]
Coarse-Grained Soils More than 50% retained on No. 200 sieve	Gravels More than 50% of coarse fraction retained on No. 4 sieve	Clean Gravels Less than 5% fines[C]	$Cu \geq 4$ and $1 \leq Cc \leq 3$[E]	GW	Well-graded gravel[F]
			$Cu < 4$ and/or $1 > Cc > 3$[E]	GP	Poorly graded gravel[F]
		Gravels with Fines More than 12% fines[C]	Fines classify as ML or MH	GM	Silty gravel[F,G,H]
			Fines classify as CL or CH	GC	Clayey gravel[F,G,H]
	Sands 50% or more of coarse fraction passes No. 4 sieve	Clean Sands Less than 5% fines[D]	$Cu \geq 6$ and $1 \leq Cc \leq 3$[E]	SW	Well-graded sand[1]
			$Cu < 6$ and/or $1 \geq Cc \geq 3$[E]	SP	Poorly graded sand[1]
		Sands with Fines More than 12% fines[D]	Fines classify as ML or MH	SM	Silty sand[G,H,I]
			Fines classify as CL or CH	SC	Clayey sand[G,H,I]
Fine-Grained Soils 50% or more passes the No. 200 sieve	Silts and Clays Liquid limit less than 50	inorganic	PI>7 and plots on or above "A" line[J]	CL	Lean clay[K,L,M]
			PI<4 or plots below "A" line[J]	ML	Silt[K,L,M]
		organic	$\frac{\text{Liquid limit - oven dried}}{\text{Liquid limit - not dried}} < 0.75$	OL	Organic clay[K,L,M] Organic silt[K,L,M,O]
	Silts and Clays Liquid limit 50 or more	inorganic	PI plots on or above "A" line	CH	Fat clay[K,L,M]
			PI plots below "A" line	MH	Elastic silt[K,L,M]
		organic	$\frac{\text{Liquid limit - oven dried}}{\text{Liquid limit - not dried}} < 0.75$	OH	Organic clay[K,L,M,P] Organic silt[K,L,M,Q]
Highly organic soils	Primarily organic matter, dark in color, and organic odor			PT	Peat

[A] Based on the material passing the 3-in. (77-mm) sieve.
[B] If field sample contained cobbles or boulders, or both, add "with cobbles or boulders or both" to group name.
[C] Gravels with 5 to 12% fines require dual symbols:
GW-GM well-graded gravel with silt
GW-GC well-graded gravel with clay
GP-GM poorly graded with silt
GP-GC poorly graded gravel with clay
[D] Sands with 5 to 12% fines require dual symbols:
SW-SM well-graded sand with silt
SW-SC well-graded sand with clay
SP-SM poorly graded sand with silt
SP-SC poorly graded sand with clay

[E] $Cu = D_{60}/D_{10}$ $\quad Cc = \dfrac{(D_{30})^2}{D_{10} \times D_{60}}$

[F] If soil contains $\geq$15% sand, add "with sand" to group name.
[G] If fines classify as CL-ML, use dual symbol GC-GM or SC-SM.
[H] If fines are organic, add "with organic fines' to group name.
[I] If soil contains $\geq$ 15% gravel, add "with gravel" to group name.
[J] If Atterberg limits plot in hatched area, soil is a CL-ML, silty clay.

[K] If soil contains 15 to 29% plus No. 200, add "with sand" or "with gravel", whichever is predominant.
[L] If soil contains $\geq$30% plus No. 200, predominantly sand, add "sandy" to group name.
[M] If soil contains $\geq$30% plus No. 200, predominantly gravel, add "gravelly" to group name.
[N] PI $\geq$4 and plots on or above "A" line.
[O] PI <4 or plots below "A" line.
[P] PI plots on or above "A" line.
[Q] PI plots below "A" line.

TABLE D-2

CRITERIA FOR DESCRIBING MOISTURE CONDITION OF CLAY SOIL	
Description	**Criteria**
Dry	Absence of moisture, dusty, dry to the touch.
Moist	Damp, slightly wet, moisture content below plastic limit.
Wet	Moisture content above the plastic limit.
Saturated	Very wet. Usually soil is below water table.

TABLE D-3

CRITERIA FOR DESCRIBING MOISTURE CONDITION OF GRANULAR SOIL	
Description	**Criteria**
Dry	Absence of moisture, dry to the touch.
Moist	Damp but no visible free water.
Wet	Visible free water.
Saturated	Usually soil is below water table.

TABLE D-4

CRITERIA FOR DESCRIBING CONSISTENCY OF CLAY SOIL	
Density	**Penetration Resistance, N Blows per 12 in.**
Very Soft	Less Than 2
Soft	2-4
Medium	4-8
Stiff	8-15
Very Stiff	15-30
Hard	Greater Than 30

TABLE D-5

CRITERIA FOR DESCRIBING DENSITY OF COARSE-GRAINED SOIL	
Density	**Penetration Resistance, N Blows per 12 in.**
Loose	Less Than 10
Medium	10-30
Dense	30-50
Very Dense	Greater Than 50

TABLE D-6

CRITERIA FOR DESCRIBING STRENGTH OF ROCK	
Description	**Criteria**
Very soft	Permits denting by moderate pressure of the fingers.
Soft	Resists denting by the fingers, but can be abraded and pierced to a shallow depth by a pencil point.
Moderately soft	Resists a pencil point, but can be scratched and cut with a knife blade.
Moderately hard	Resistant to abrasion or cutting by a knife blade, but can be easily dented or broken by light blows of a hammer.
Hard	Can be deformed or broken by repeated moderate hammer blows.
Very hard	Can be broken only by heavy, and in some rocks, repeated hammer blows.

TABLE D-7

ROCK QUALITY DESIGNATION (RQD)

This is a general method by which the quality of the rock at a site is obtained based on the relative amount of fracturing and alteration.

The Rock Quality Designation (RQD) is based on a modified core recovery procedure that, in turn, is based indirectly on the number of fractures (except those due directly to drilling operations) and the amount of softening or alteration in the rock mass as observed in the rock cores from a drill hole. Instead of counting the fractures, an indirect measure is obtained by summing the total length of core recovered by counting only those pieces of hard and sound core which are 4 inches or greater in length. The ratio of this modified core recovery length to the total core run length is known as the RQD.

An example is given below from a core run of 60 inches. For this particular case, the total core recovery is 50 inches yielding a core recovery of 83 percent. On the modified basis, only 38 inches are counted the RQD is 63 percent.

CORE RECOVERY, in.	MODIFIED CORE RECOVERY, in.
10	10
2	
2	
3	
4	4
5	5
3	
4	4
6	6
4	4
2	
5	5
---	---
50	38

% Core Recovery = 50/60 = 83%; RQD = 38/60 = 63%

A general description of the rock quality can be made for the RQD Value.

RQD (ROCK QUALITY DESIGNATION)	DESCRIPTION OF ROCK QUALITY
0 – 25	very poor
25 – 50	poor
50 – 75	fair
75 – 90	good
90 – 100	excellent

APPENDIX E. UNCONFINED COMPRESSION TEST RESULT

LINCOLN OFFICE
825 "J" Street
P.O. Box 80358
Lincoln, Nebraska
(402) 479-2200

HWS Solutions Through Service

UNCONFINED - COMPRESSION TEST

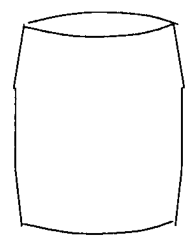
ASTM Designation: D 2166-98a

Project: **N 70th & Bluff Rd. -- Lincoln City Communication Tower**

Job No.	**52-86-3276**	Boring No.	**B-1**	Depth	**10.4'-11.1'**
Sample No.	**T-2**	Lab No.	**18125**	Classification	**CL**
Type of Specimen	**3" Tube**			Humidity During Trimming	**75%**
Remarks	**Glacial Till**				

MOISTURE	
Container Number	931
Total Wet Wt. (g)	239.9
Total Dry Wt. (g)	196.8
Container Wt. (g)	45.2
Water Content (%)	28.4
Saturation (%)	92.5

SKETCH



Specimen Diameter (in)	2.863
Initial Length (in)	6.076
Wet Wt. of Specimen (g)	1209.5
End Area (in^2)	6.44
Volume (in^3)	39.12
Wet Unit Wt. (lbs/ft^3)	117.8
Dry Unit Wt. (lbs/ft^3)	91.7
Length/Diameter	2.1

	(lbs/in^2)	($tons/ft^2$)
Uncon. Compressive Strength =	**14.1**	**1.0**
Shear Strength =	**7.1**	**0.5**

Strain at failure = 1.2%
Avg. Strain Rate (%/min) = 0.9%

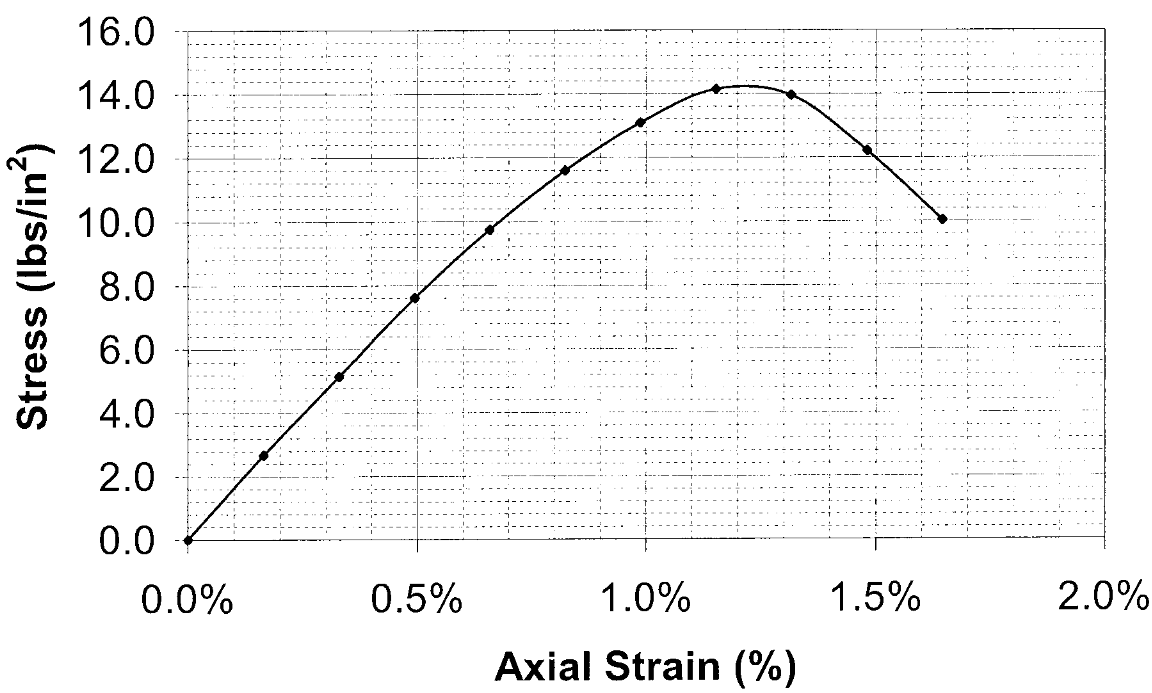


Figure E-1

APPENDIX F. TRIAXIAL COMPRESSION TEST RESULT

HWS

LINCOLN OFFICE
825 J St., Box 80358
Lincoln, NE 68501

TRIAXIAL SHEAR TEST

PROJECT and STATE	SAMPLE LOCATION
N 70TH & BLUFF ROAD -- LINCOLN CITY COMMUNICATION TOWER	B-1

FIELD SAMPLE NO.	DEPTH	GEOLOGIC ORIGIN
T-1	5.7'-6.3'	

TYPE OF SAMPLE	TESTED AT	APPROVED BY	DATE
3" Tube	HWS - LINCOLN, NE	B.D.	10/14/2005

INDEX TEST DATA

USCS ____; LL ____; PI ____

%FINER(mm): 0.002 ____; 0.005 ____;

0.074(#200) ____

G_S (-#4) ____; G_S (+#4) ____

STANDARD: γ_d MAX. ____ pcf; W_O ____ %

MODIFIED: γ_d MAX. ____ pcf; W_O ____ %

SPECIMEN DATA

HEIGHT 2.94 "; DIAMETER 1.4 "

MATERIALS TESTED PASSED ____ SIEVE

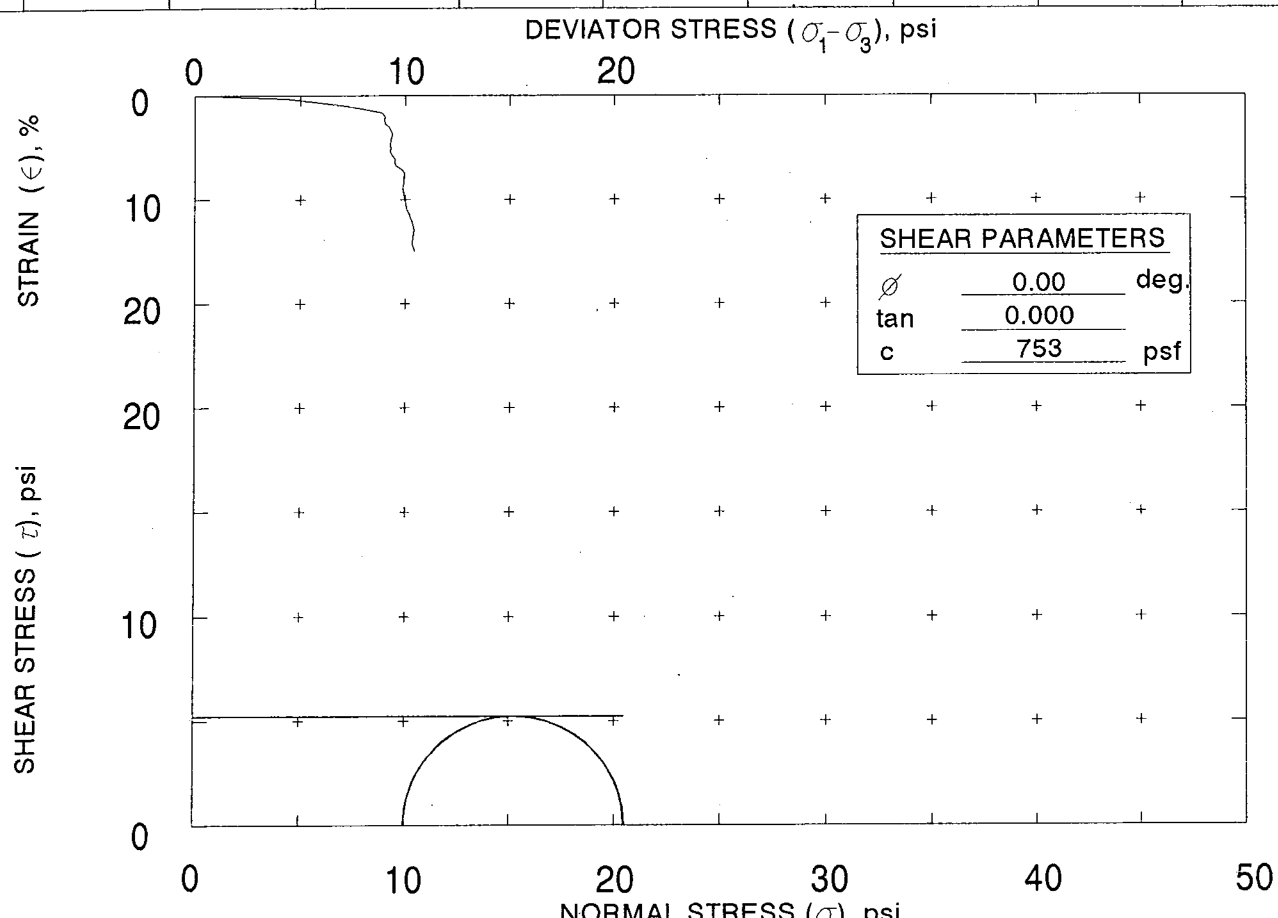
METHOD OF PREPARATION TRIMMED FROM A 3" TUBE SAMPLE

MOLDING MOISTURE ____ %

MOLDED AT ____ % OF γ_d MAXIMUM

TYPE OF TEST: UU ☒ CU ☐ $\overline{CU}$ ☐ CD ☐

DRY DENSITY INITIAL (pcf ☒ g/cc ☐)	DRY DENSITY CONSOLIDATED (pcf ☐ g/cc ☐)		MOISTURE CONTENT, % START OF TEST	DEG. OF SAT. AT START OF TEST	END OF TEST		MINOR PRINCIPAL STRESS σ_3 (psi.)	DEVIATOR STRESS $\sigma_1 - \sigma_3$ (psi.)	AXIAL STRAIN AT FAILURE, ϵ (%)
94.3			20.2	69.8	*		10.0	10.5	14.97
94.3			20.2	69.8	*		10.0	10.5	14.97
*			*	*			0.0		



REMARKS

PROJECT	N 70th & Bluff Road; Lincoln City Communication Tower		
LAB NO.	18441	SAMPLE IDB-1; T-1; 5.7'-6.3'	
CELL NO.	3	JOB NO.	52-86-3276.0104

CELL PRESSURE	80.0	SP. GR.	2.68
BACK PRESSURE	70.0		
CONFINING PRESS.	10.0		

SPECIMEN DATA	INITIAL	FINAL	MOISTURE DATA	INITIAL	FINAL
DIAMETER			CAN NUMBER	995	
TOP, in.	1.405		TOTAL WET WT.,gm	231.41	
MIDDLE, in.	1.406		TOTAL DRY WT.,gm	200.07	
BOTTOM, in.	1.406		WT. OF WATER, gm	31.34	0.00
AVERAGE DIA.,in.	1.406	0.000	CAN WEIGHT, gm	44.71	
HEIGHT, in.	2.940		DRY WT. SOIL, gm	155.36	0.00
MOIST WT., gm	135.74		PERCENT MOISTURE	20.17	ERR
END AREA,sq.in.	1.552		DRY UNIT WT.,pcf	94.29	ERR
VOLUME, cu. in.	4.56		THEO. SAT.,%	69.81	XXXXXXXXX
UNIT WT., gm/cc	1.815				
WET UNIT WT,pcf	113.31		HEIGHT CHANGE,in.		0.000

AXIAL DIAL in.	AXIAL LOAD lbs.	PORE PRESS u	STRAIN %	DEVIATOR STRESS	GEN PORE PRESS	SIGMA THREE (BAR)	SIGMA ONE (BAR)	PRIN. STRESS RATIO	SIGMA SUB ALPHA	TAU SUB ALPHA
0.000	16.1	70.00	0.00	0.00	0.00	10.00	10.00	1.00	10.00	0.00
0.010	22.8		0.34	4.30	-70.00	80.00	84.30	1.05	81.08	1.86
0.020	25.3		0.68	5.89	-70.00	80.00	85.89	1.07	81.47	2.55
0.030	27.2		1.02	7.08	-70.00	80.00	87.08	1.09	81.77	3.07
0.040	28.8		1.36	8.07	-70.00	80.00	88.07	1.10	82.02	3.49
0.050	30.1		1.70	8.87	-70.00	80.00	88.87	1.11	82.22	3.84
0.060	30.4		2.04	9.03	-70.00	80.00	89.03	1.11	82.26	3.91
0.070	30.4		2.38	8.99	-70.00	80.00	88.99	1.11	82.25	3.89
0.080	30.5		2.72	9.03	-70.00	80.00	89.03	1.11	82.26	3.91
0.090	30.9		3.06	9.24	-70.00	80.00	89.24	1.12	82.31	4.00
0.100	31.0		3.40	9.27	-70.00	80.00	89.27	1.12	82.32	4.02
0.110	31.2		3.74	9.37	-70.00	80.00	89.37	1.12	82.34	4.06
0.120	31.2		4.08	9.33	-70.00	80.00	89.33	1.12	82.33	4.04
0.130	31.2		4.42	9.30	-70.00	80.00	89.30	1.12	82.32	4.03
0.140	31.2		4.76	9.27	-70.00	80.00	89.27	1.12	82.32	4.01
0.150	31.3		5.10	9.29	-70.00	80.00	89.29	1.12	82.32	4.02
0.160	31.3		5.44	9.26	-70.00	80.00	89.26	1.12	82.32	4.01
0.170	31.5		5.78	9.35	-70.00	80.00	89.35	1.12	82.34	4.05
0.180	31.8		6.12	9.50	-70.00	80.00	89.50	1.12	82.37	4.11
0.190	31.8		6.46	9.46	-70.00	80.00	89.46	1.12	82.37	4.10
0.200	32.0		6.80	9.55	-70.00	80.00	89.55	1.12	82.39	4.13
0.210	32.5		7.14	9.81	-70.00	80.00	89.81	1.12	82.45	4.25
0.220	32.8		7.48	9.95	-70.00	80.00	89.95	1.12	82.49	4.31
0.260	32.9		8.84	9.87	-70.00	80.00	89.87	1.12	82.47	4.27
0.280	33.1		9.52	9.91	-70.00	80.00	89.91	1.12	82.48	4.29
0.300	33.4		10.20	10.01	-70.00	80.00	90.01	1.13	82.50	4.33
0.320	33.6		10.88	10.05	-70.00	80.00	90.05	1.13	82.51	4.35
0.340	34.0		11.56	10.20	-70.00	80.00	90.20	1.13	82.55	4.42
0.360	34.4		12.24	10.35	-70.00	80.00	90.35	1.13	82.59	4.48
0.380	34.7		12.93	10.44	-70.00	80.00	90.44	1.13	82.61	4.52
0.400	34.7		13.61	10.35	-70.00	80.00	90.35	1.13	82.59	4.48
0.420	34.8		14.29	10.33	-70.00	80.00	90.33	1.13	82.58	4.47
0.440	35.2		14.97	10.46	-70.00	80.00	90.46	1.13	82.62	4.53
0.441	35.2		15.00	10.46	-70.00	80.00	90.46	1.13	82.62	4.53
0.480			16.33	-8.68	-70.00	80.00	71.32	0.89	77.83	-3.76
0.500			17.01	-8.61	-70.00	80.00	71.39	0.89	77.85	-3.73
0.520			17.69	-8.54	-70.00	80.00	71.46	0.89	77.87	-3.70
0.540			18.37	-8.47	-70.00	80.00	71.53	0.89	77.88	-3.67
0.560			19.05	-8.40	-70.00	80.00	71.60	0.90	77.90	-3.64
0.580			19.73	-8.33	-70.00	80.00	71.67	0.90	77.92	-3.61
0.600			20.41	-8.26	-70.00	80.00	71.74	0.90	77.94	-3.58
0.620			21.09	-8.19	-70.00	80.00	71.81	0.90	77.95	-3.54
0.640			21.77	-8.12	-70.00	80.00	71.88	0.90	77.97	-3.51
0.660			22.45	-8.04	-70.00	80.00	71.96	0.90	77.99	-3.48
0.680			23.13	-7.97	-70.00	80.00	72.03	0.90	78.01	-3.45

VOLUME CC	74.79	STRAIN	
MOISTURE	20.17	14.97	
DRY DENSITY	94.29		
SATURATION	69.81		
CONSOL HT	2.940		
CON END AREA	1.552	STRAIN	
FINAL DRY DEN	ERR	14.97	
FINAL MOIST	ERR		

TOTAL STRESS VALUES

DSTRESS	GENPORPR	SIG3	SIG1	CENTER		
10.46	-70.00	10.00	20.46	15.23		

EFFECTIVE STRESS VALUES

DSTRESS	GENPORPR	SIG3	SIG1	CENTER		
10.46	-70.00	80.00	90.46	85.23	82.61613	4.531144
					82.61613	4.531144